Metal Compression Forming

Lightweight, High-Strength Aluminum Components

ENERGY EFFICIENCY AND RENEWABLE ENERGY

OFFICE OF TRANSPORTATION TECHNOLOGIES

Transportation

FOR THE 21ST CENTURY

Background

More and more, aluminum components are being used in place of iron or steel components in vehicles. This reduces the weight of the vehicle significantly, leading to improvements in fuel economy. Thompson Aluminum Casting (TAC) worked from 1985 to 1994 to develop aluminum forming processes that would produce high-strength aluminum parts cost effectively. TAC's process integrates the attributes of traditional squeeze casting with low-pressure permanent mold casting in a new metal compression forming (MCF) process. In 1995, under a Cooperative Research and Development Agreement, TAC collaborated with Oak Ridge National Laboratory (ORNL) to utilize their capabilities in modeling, metallurgy, and materials characterization to bring the metal forming process to fruition. To optimize the process, researchers coupled the analysis of the thermophysical properties of aluminum alloys with the use of casting and solidification models to simulate the die-casting and solidification steps.

The Technology

Traditional squeeze casting does not allow pressure to be applied uniformly within the die. The MCF process, however, permits pressure to be applied equally to all regions of the die, which produces components with fewer cavity and pore defects leading to improved strength characteristics. MCF is a process for producing strong, lightweight aluminum components that are suitable for use in safety critical applications. Cost savings are achieved through a three-step process, whereas traditional forging requires a labor-intensive nine-step process. Additionally, cost savings result from high process yields (percent of metal that is succesfully made into components) of about 95 percent. The results of the TAC and ORNL collaboration won an R&D 100 Award in 1997.

Commercialization

The success of the MCF process attracted the attention of designers at GM-Delphi, who were exploring the use of a new design for engine mounts. To gain the confidence of GM-Delphi, the new component had to meet specific certification and qualification requirements. The team responded by quickly developing an aluminum 356 alloy motor mount bracket that met the vehicle manufacturer's production schedule and was accepted by industry. The process consistently produced a strong component that demonstrated superior stress cracking characteristics. Its success led GM-Delphi to place an initial order for 400,000 aluminum engine mounts for model year 2000 vehicles. To date, the MCF process has been identified as a low cost solution to reduce the weight of safety critical parts by 400 pounds and increasing fuel economy by 6%. For every 10% reduction in weight of the vehicle TAC has licensed the MCF process to TTE Diecasting to increase capacity for GM-Delphi orders and expected future demand.

Benefits

- **6% improvement for every 10% reduction in weight**
- **6% reduction in vehicle emissions**
- **Lowers costs by up to two-thirds compared to traditional forging**
- **Process yields of 95%**

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